

CLAIMS

1. A method of providing a silent mode of operation for a hybrid electric vehicle having a rechargeable energy storage system (ESS), comprising the steps of:

- (1) transmitting a silent mode initiation request to a silent mode controller;
- 5 (2) comparing an actual value of at least one state parameter of the ESS that is indicative of the availability of the ESS for implementing the silent mode to at least one silent mode initiation limit value associated with the actual value, wherein if the actual value of the at least one state parameter compared to the associated at least one mode initiation
10 limit value indicates that the silent mode is allowed, the method proceeds to step (3), and wherein if the actual value of the at least one state parameter indicates that the silent mode is not allowed, step (2) is repeated so long as the silent mode initiation request is being transmitted;
- 15 (3) transmitting a silent mode activation request to the silent mode controller;
- (4) operating the vehicle in the silent mode using the silent mode controller, comprising designating an electric drive motor as a primary source of propulsion energy for the vehicle and designating an engine
20 as a secondary source of the propulsion energy for the vehicle, wherein a modal quantity of energy in the ESS is allocated for use by the electric drive motor during the silent mode and the engine is used to make up the difference between the modal quantity of energy and a total vehicle propulsion energy requirement during the silent mode;
25 and
- (5) terminating the silent mode in response to the occurrence of a mode termination event.

2. The method of claim 1, wherein the step of transmitting a silent mode initiation request is selected from the group consisting of: (a) manual

transmitting of the silent mode initiation request by a vehicle operator, (b) automatic transmitting of the silent mode initiation request as a function of an absolute position of the vehicle, and (c) automatic transmitting of the silent mode initiation request as a function of a relative position of the vehicle to a region in which silent mode operation of the vehicle is desired.

3. The method of claim 1, comprising the further step of: (2A) precharging the ESS prior to initiation of a silent mode.

4. The method of claim 3, wherein the step of precharging the ESS comprises precharging the ESS to a state of charge (SOC) value that is less than or equal to a target precharge SOC limit.

5. The method of claim 4, wherein the target precharge SOC limit value is in the range of about 60-75 percent.

6. The method of claim 3, wherein the step of precharging the ESS comprises charging the ESS at a maximum charging power of the vehicle.

7. The method of claim 1, comprising the further step of: (4A) limiting an output power of the engine while the vehicle is in the silent mode to a silent mode output power limit that is less than a maximum output power of the engine.

8. The method of claim 7, wherein the silent mode output power limit of the engine is automatically controlled as a function of a vehicle speed.

9. The method of claim 8, wherein the maximum silent mode output power limit of the engine is a function of an ESS budget factor, and wherein as the ESS budget factor decreases, the maximum silent mode output power limit is increased and the vehicle stop threshold value is decreased.

10. The method of claim 9, wherein the silent mode output power limit is zero at vehicle speeds that are less than a vehicle stop threshold value.

11. The method of claim 10, further comprising rotating the engine without fuel at vehicle speeds that are less than the vehicle stop threshold value.

12. The method of claim 11, further comprising stopping the rotation of the engine in response to an engine stop event.

13. The method of claim 12, further comprising starting the rotation of the engine in response to an engine start event.

14. The method of claim 1, wherein the modal quantity of energy allocated for use by the electric drive motor during the silent mode according to an ESS energy budget that is a function of a distance associated with a target zone of silent mode operation.

15. The method of claim 14, wherein modal quantity of energy comprises a fixed portion of a maximum SOC of the ESS.

16. The method of claim 15, wherein the modal quantity of energy is about 25% the maximum SOC.

17. The method of claim 14, wherein ESS energy budget is adjusted as a function of the SOC of the ESS at a predetermined time associated with the silent mode activation request.

18. The method of claim 17, wherein the predetermined time is the time that silent mode activation request is transmitted.

19. The method of claim 1, wherein the mode termination event is selected from the group consisting of: (a) manual transmitting of a silent mode termination request by a vehicle operator, (b) automatic transmitting of a silent mode termination request as a function of the absolute position of the vehicle,
5 (c) automatic transmitting of a silent mode termination request as a function of a relative position of the vehicle to a region in which silent mode operation of the vehicle is desired a manual mode termination command, (d) reaching a predetermined silent mode elapsed time limit, (e) reaching a predetermined silent mode elapsed distance limit, and (f) reaching at least one ESS state
10 parameter termination limit.

20. The method of claim 19, wherein the termination event comprises reaching at least one ESS state parameter, and wherein the state parameter comprises an ESS temperature.

21. The method of claim 20, wherein the termination event comprises reaching at least one ESS state parameter, and wherein the state parameter comprises an SOC limit.

22. The method of claim 21, wherein the ESS SOC silent mode termination limit value is a range of SOC, wherein $20\% \geq \text{SOC} \geq 90$.

23. A method of providing a silent mode of operation for a hybrid electric vehicle having a rechargeable battery, comprising the steps of:
(1) transmitting a silent mode initiation request to a silent mode controller;
(2) comparing a battery temperature to a mode initiation battery
5 temperature limit value, wherein if the battery temperature is less than or equal to the mode initiation battery temperature limit value, the method proceeds to step (3), and wherein if the battery temperature is greater than the mode initiation battery temperature limit value, step
(2) is repeated so long as the mode initiation request is being
10 transmitted;

- (3) precharging the battery prior to initiation of a silent mode;
- (4) transmitting a silent mode activation request to the silent mode controller;
- (5) operating the vehicle in the silent mode using the silent mode controller, comprising designating an electric drive motor as a primary source of propulsion energy for the vehicle and designating an engine as a secondary source of the propulsion energy for the vehicle, wherein a modal quantity of energy in the battery is allocated for use by the electric drive motor during the silent mode and the engine is used to make up the difference between the modal quantity of energy and a total vehicle propulsion energy requirement during the silent mode; and
- (6) terminating the silent mode in response to the occurrence of a mode termination event.

24. The method of claim 23, wherein the step of precharging the battery comprises precharging the battery to a state of charge (SOC) value that is less than or equal to a target precharge SOC limit.

25. The method of claim 23, comprising the further step of: (5A) limiting an output power of the engine while the vehicle is in the silent mode to a maximum silent mode output power limit that is less than a maximum output power of the engine.

26. The method of claim 23, wherein the maximum silent mode output power limit of the engine is a function of an ESS budget factor, wherein as the battery budget factor decreases, the maximum silent mode output power limit is increased.

27. The method of claim 23, wherein the mode termination event is selected from the group consisting of: (a) manual transmitting of a silent mode termination request by a vehicle operator, (b) automatic transmitting of a

- silent mode termination request as a function of the absolute position of the vehicle, (c) automatic transmitting of a silent mode termination request as a function of a relative position of the vehicle to a region in which silent mode operation of the vehicle is desired a manual mode termination command, (d) reaching a predetermined silent mode elapsed time limit, (e) reaching a predetermined silent mode elapsed distance limit, and (f) the battery temperature reaching a predetermined battery termination limit value, and (g) a battery SOC reaching a predetermined SOC termination limit value.